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(71) Applicant *(for all designated States except US)*: **CHEIL INDUSTRIES INC.** [KR/KR]; 290 Gongdan-dong, Kumi-shi, 730-710 Kyungsangbuk-do (KR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **YANG, Jae Ho** [KR/KR]; Haanyangbaekdu Apt. 981-1205, 1119 San-bon-dong, Gunpo-si, 435-040 Gyeonggi-do (KR). **HONG, Sang Hyun** [KR/KR]; Seorak Apt. 857-704, Suri-dong, Gunpo-si, 435-753 Gyeonggi-do (KR). **LEE, Gyu Chul** [KR/KR]; Jugong Apt. 150-106,, 333 Cheoncheon-dong, Jangan-gu, Suwon-si, 440-330 Gyeonggi-do (KR). **JANG, Young Gil** [KR/KR]; 141-94 Sadang3-dong, Dongjak-gu, 156-093 Seoul (KR). **BAE, Su Hak** [KR/KR]; Hyundai Apt. 101-810,, 707 Seongsu1ga2-dong, Seongdong-gu, 133-112 Seoul (KR).

(74) Agent: **CHOI, Duk Kyu**; 5th Floor Chunwoo Bldg., 736 Yoksam-dong, Kangnam-gu, 135-080 Seoul (KR).

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(54) Title: FLAME RETARDANT THERMOPLASTIC RESIN COMPOSITION

(57) Abstract: The present invention relates to a flame retardant thermoplastic resin composition that contains a phenol resin derivative having good char formability, regardless of the base resin. A flame retardant thermoplastic resin composition according to the present invention comprises (A) 100 parts by weight of a thermoplastic resin as a base resin, (B) about 0.1~100 parts by weight of a phenol resin derivative, and (C) about 0.1~50 parts by weight of a phosphorous compound or a mixture of phosphorous compounds.

FLAME RETARDANT THERMOPLASTIC RESIN COMPOSITION

Field of the Invention

The present invention relates to a thermoplastic resin composition with good flame retardancy. More particularly, the present invention relates to a flame retardant thermoplastic resin composition that contains a phenol resin derivative having good char formability, regardless of the base resin.

Background of the Invention

To improve flame retardancy of a thermoplastic resin composition is a major target to the research and development of the resin for a long time. It has been known the best method of using a halogen compound to prepare a flame retardant thermoplastic resin composition. U.S. Patent Nos. 4,983,658 and 4,883,835 disclose thermoplastic resin compositions using a halogen compound as a flame retardant. The thermoplastic resin composition using a halogen compound shows good flame retardancy regardless of the base resin. However, the disadvantages could be observed that the halogen-containing compound results in the corrosion of the mold itself by the hydrogen halide gases released during the molding process and is fatally harmful due to the toxic gases liberated in case of fire. Therefore, halogen-free flame retardants have become a major concern in this field.

The representative halogen-free flame retardant is a phosphorous flame retardant nowadays. The phosphorous compound is superior to the halogen compound in corrosion of apparatus and toxic gas liberation. However, the phosphorous compound cannot provide better flame retardancy than the halogen compound, and, if more amount of the phosphorous compound is used to improve flame retardancy, the heat resistance is deteriorated. Furthermore, base resins are

limited when the phosphorous compound is used as a flame retardant.

Another method to improve flame retardancy of a thermoplastic resin composition is add a material with good char formability to the base resin with poor char formability to form char film during combustion. The char film blocks transporting of oxygen, heat, and other fuel gases which could accelerate combustion of the resin.

As a phenol resin has a good char formability, it has been targeted to conduct a research of the flame retardant thermoplastic resin composition. However, the phenol resin has disadvantages that the intensity of the char film is not so strong, the phenol resin has a poor compatibility with other resin due to polarity of the resin, and a color change problem occurs because of weak weatherability.

Accordingly, the present inventors have developed a flame retardant thermoplastic resin composition that employs a phenol resin derivative which overcome the shortcomings above of the phenol resin. In the flame retardant thermoplastic resin composition according to the present invention, the phenol resin derivative solves the color change problem due to use of phenol resin and improves compatibility with other polymer resins. The phenol resin derivative provides the flame retardant thermoplastic resin composition with good char formability.

Objects of the Invention

A feature of the present invention is the provision of a thermoplastic resin composition with excellent flame retardancy, regardless of the base resin.

Another feature of the present invention is the provision of a thermoplastic resin composition with good weatherability against ultraviolet and good compatibility with other polymer resins.

A further feature of the present invention is the provision of a thermoplastic resin composition that does not result in corrosion of the mold apparatus by the hydrogen halide gases released during the molding process and that does not liberate

toxic gases in case of fire.

Other objects and advantages of this invention will be apparent from the ensuing disclosure and appended claims.

Summary of the Invention

A flame retardant thermoplastic resin composition according to the present invention comprises (A) 100 parts by weight of a thermoplastic resin as a base resin, (B) about 0.1~100 parts by weight of a phenol resin derivative, and (C) about 1~50 parts by weight of a phosphorous compound or a mixture of phosphorous compounds.

Detailed Description of the Invention

(A) Thermoplastic Resin (Base Resin)

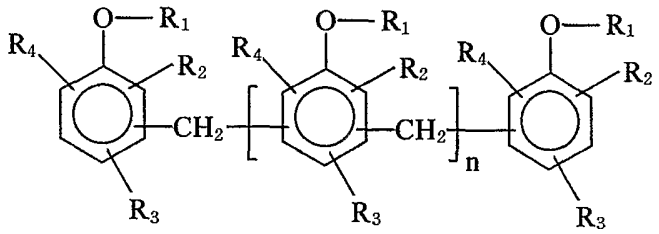
Any thermoplastic resin can be used as a base resin in the present invention. In case of using a phosphorous compound as a flame retardant, the base resin is limited because it is difficult to obtain a sufficient flame retardancy. However, in the present invention, as both a phenol resin derivative and a polyphenylene ether resin are employed, a thermoplastic resin with no or poor char formability can be used as a base resin, resulting in sufficient flame retardancy.

The examples of the thermoplastic resin as base resin include polyacrylonitrile-butadiene-styrene copolymer (ABS resin), rubber modified polystyrene resin (HIPS), acrylonitrile-styrene-acrylate copolymer (ASA resin), methacrylate-butadiene-styrene copolymer (MBS resin), acrylonitrile-ethacrylate-styrene copolymer (AES resin), polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET),

polybutylene terephthalate (PBT), polyvinyl chloride (PVC), polymethyl methacrylate (PMMA), polyamide (PA), and a copolymer thereof and an alloy thereof.

(B) Phenol Resin Derivative

When a phenol resin is used in a thermoplastic resin composition to improve flame retardancy, the phenol resin has disadvantages that the intensity of the char film is not so strong, the phenol resin has a poor compatibility with other resin due to polarity of the resin, and a color change problem occurs because of weak weatherability against ultraviolet. A phenol resin derivative is used to overcome the shortcomings of a phenol resin. The phenol resin derivative has good compatibility with other polymer resins to be used. The phenol resin derivative is used to provide the base resin with good char formability so as to improve flame retardancy, which has a chemical structure represented by the following Formula (I):



(I)

where R_1 is alkyl of C_{1-34}; aryl; alkyl-substituted aryl; O-, N-, P- or S-containing alkyl; O-, N-, P- or S-containing aryl; or O-, N-, P- or S-containing alkyl-substituted aryl; R_2, R_3, and R_4 are hydrogen, alkyl of C_{1-34}; aryl; alkyl-substituted aryl; O-, N-, P- or S-containing alkyl; O-, N-, P- or S-containing aryl; or O-, N-, P- or S-containing alkyl-substituted aryl; and n is an integer of 1 to 10,000, preferably 1 to 300 considering mechanical properties and processability.

During combustion, the phenol resin derivative prevents the combusted gases

from flowing out by forming char film and oxygen or air from flowing in, functioning as a flame retardant additive. The phenol resin derivative overcomes disadvantages of phenol resin when the phenol resin is used in a thermoplastic resin composition, which are weak intensity of the char film, poor compatibility with other resin due to polarity of the phenol resin, and a color change problem due to weak weatherability.

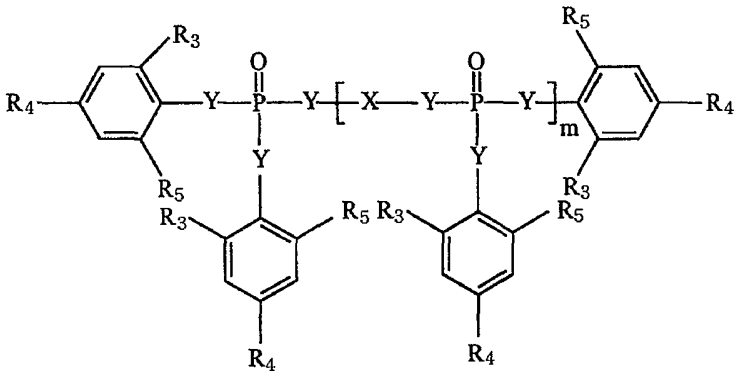
The preferable examples of the phenol resin derivative include o-cresol novolak epoxy resin and phenol epoxy resin. The phenol resin derivatives are used in single or in mixture.

The phenol resin derivative may be used in the amount of about 0.01 to 100 parts by weight based on 100 parts by weight of the base resin.

(C) Phosphorous Compound

The phosphorous compound usable in the present invention include a phosphoric acid ester compound, a phosphoamidate compound, an oxaphosphorane compound, a carboxy phosphinic acid compound, phosphoric acid ester morpholide compound and a phosphazene compound. The phosphorous compounds are used in single or in combination. The phosphorous compound may be used in the amount of about 1 to 50 parts by weight based on 100 parts by weight of the base resin. The phosphorous compounds are described in detail as follow:

Phosphoric Acid Ester Compound and Phosphoamidate Compound: The phosphoric acid ester compound and phosphoamidate compound are represented by the following chemical Formula (II):

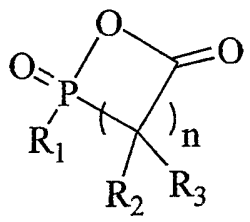


(II)

where R_3, R_4 and R_5 are hydrogen or alkyl of C_{1-4}, X is aryl of C_{6-20} or aryl of alkyl-substituted C_{6-20} that are derivatives from dialcohol such as resorcinol, hydroquinol, bisphenol-A and bisphenol-S, Y is oxygen or nitrogen, and m is in the range of 0 to 4.

If m is 0 in Formula (II), the compounds may be triphenyl phosphate, tricresyl phosphate, trixylenyl phosphate, tri(2,6-dimethylphenyl) phosphate, tri(2,4,6-trimethylphenyl) phosphate, tri(2,4-ditertiarybutylphenyl) phosphate, tri(2,6-ditertiarybutylphenyl) phosphate and the like, and if m is 1, the compounds may be resorcinolbis(diphenyl) phosphate, resorcinolbis(2,6-dimethylphenyl) phosphate, resorcinolbis(2,4-ditertiary butylphenyl) phosphate, hydroquinol(2,6-dimethylphenyl) phosphate, hydroquinol(2,4-ditertiarybutylphenyl) phosphate and the like. The phosphorous compounds are used in single or in combination.

Oxaphosphorane Compound: The oxaphosphorane compound is represented by the following chemical Formula (III):

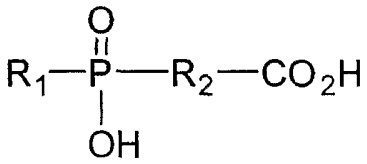


(III)

where R_1 is hydrogen, alkyl of C_{1-6}, or aryl of C_{6-15}, R_2 and R_3 are hydrogen or alkyl of C_{1-6}, and n is in the range of 1 to 3.

The preferable examples of the oxaphosphorane compound are 2-methyl-2, 5-dioxo-1-oxa-2-phosphorane and 2-phenyl-2, 5-dioxo-1-oxa-2-phosphorane. The oxaphosphorane compounds are used in single or in combination.

Carboxy Phosphinic Acid Compound: The carboxy phosphinic acid compound is represented by the following chemical Formula (IV):

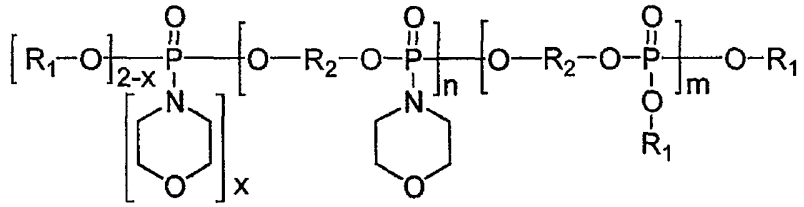


(IV)

where R_1 is hydrogen, alkyl of C_{1-12}, aryl of C_{6-10}, or alkyl-substituted aryl of C_{7-15}, R_2 is alkylene of C_{1-12}, ring type alkylene of C_{1-12}, aryl of C_{6-12}, or alkyl-substituted aryl of C_{6-12}.

The preferable examples of the carboxy phosphinic acid compound are 2-carboxy-ethyl-methyl-phospanic acid, 2-carboxy-ethyl-phenyl-phospanic acid, and 2-carboxy-methyl-phenyl-phospanic acid. The carboxy phosphinic acid compounds are used in single or in combination.

Phosphoric Acid Ester Morpholide Compound: The phosphoric acid ester morpholide compound is represented by the following chemical Formula (V):



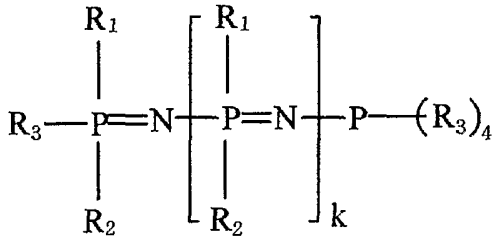
(V)

where R_1 is a C_{6-20} aryl group or an alkyl-substituted C_{6-20} aryl group, R_2 is a C_{6-30} aryl group or an alkyl-substituted C_{6-30} aryl group, x is 1 or 2, and n and m are number average degree of polymerization and n+m is 0 to 5.

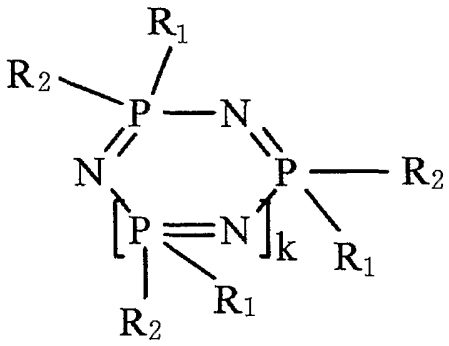
In Formula (V), preferably R_1 is a phenyl group or an alkyl-substituted phenyl group where the alkyl is methyl, ethyl, isopropyl, t-butyl, isobutyl, isoamyl or t-amyl, preferably methyl, ethyl, isopropyl or t-butyl, and R_2 means preferably a C_{6-30} aryl group or an alkyl-substituted C_{6-30} aryl group which is a derivative from resorcinol, hydroquinone or bisphenol-A.

The phosphoric acid ester morpholide compounds are used in single or in combination.

Phosphazene Compound: The linear phosphazene compound is represented by the following chemical Formula (VI) and the cyclic phosphazene compound is represented by the following chemical Formula (VII):



(VI)



(VII)

where R_1, R_2, and R_3 are independently alkyl, aryl, alkyl substituted aryl, aralkyl, alkoxy, aryloxy, amino or hydroxyl, and k is an integer from 0 to 10. The alkoxy and aryloxy groups may be substituted with alkyl, aryl, amino, hydroxyl, nitrile, nitro, aryl with hydroxy, and the like.

Other additives may be used in the thermoplastic resin composition of the present invention. The additives include an impact modifier, a heat stabilizer, an oxidation inhibitor, a light stabilizer, and an inorganic filler such as talc, silica, mica, glass fiber, an organic or inorganic pigment and/or dye. The additives are employed up to about 50 parts by weight as per 100 parts by weight of the base resin.

The invention may be better understood by reference to the following examples which are intended for the purpose of illustration and are not to be construed as in any way limiting the scope of the present invention, which is defined in the claims appended hereto. In the following examples, all parts and percentage are by weight unless otherwise indicated.

Examples

The components to prepare flame retardant thermoplastic resin compositions in Examples 1～12 and Comparative Examples 1～6 are as follows:

(A) Thermoplastic Resin (Base Resin)

(A_1) High Impact Polystyrene (HIPS)

The high impact polystyrene was prepared through a conventional process, having 9 % by weight of rubber content, 1.5 μm of average rubber particle size, and 220,000 of weight average molecular weight.

(A_2) SAN Graft Copolymer

50 parts of butadiene rubber latex powder, 36 parts of styrene, 14 parts of acrylonitrile and 150 parts of deionized water were mixed. To the mixture, 1.0 parts of potassium oleate, 0.4 parts of cumenhydroperoxide, 0.2 parts of mercaptan-containing chain transfer agent, 0.4 parts of glucose, 0.01 parts of iron sulfate hydroxide and 0.3 parts of pyrophosphate sodium salt were added. The blend was kept at 75℃ for 5 hours to obtain ABS latex. To the ABS latex, 0.4 parts of sulfuric acid was added, coagulated and dried to obtain styrene-containing graft copolymer resin (g-ABS) in powder form.

(A_3) SAN copolymer

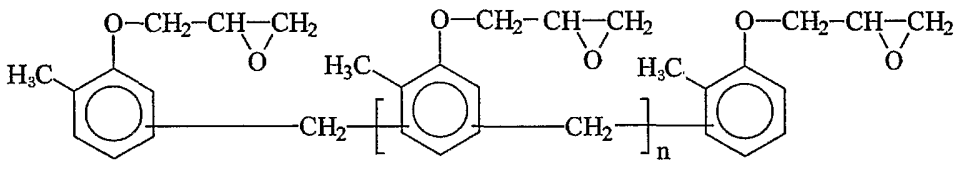
75 parts of styrene, 25 parts of acrylonitrile, 120 parts of deionized water, 0.15 parts of azobisisobutylonitrile (AIBN) were blended. To the blend, 0.4 parts of tricalciumphosphate and 0.2 parts of mercaptan-containing chain transfer agent were added. The resultant solution was heated to 80℃ for 90 minutes and kept for 180 minutes. The resultant was washed, dehydrated and dried. Styrene-acrylonitrile copolymer (SAN) was obtained.

(A_4) Polycarbonate Resin

Polycarbonate of linear bisphenol-A type with a weight average molecular weight of 25,000 was used.

(B) Phenol Resin Derivative

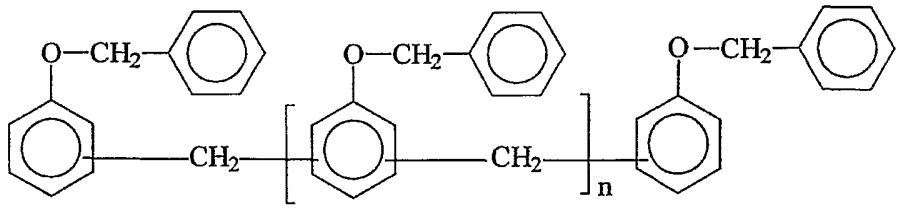
(B_1) The phenol resin derivative by Kukdo Chemical Co. of Korea (product name: YDCN-500-7P) was used, being represented by the following Formula (VIII):



(VIII)

where n has an average value of 2.3.

(B_2) Novolak resin of 50 g with a softening point of 85 °C, 200 g of benzyl chloride, and 150 g of isopropanol were dissolved in 20 ml of water, and the resulting solution was heated to 70 °C. With agitation, 100 g of 20 % NaOH was added to the solution over 1 hour. After reaction for more two hours, the solution was cooled to room temperature. The organic layer was separated from the water layer, and washed with distilled water several times. The separated organic layer was vacuum-distilled to remove benzyl chloride and solvent. The resultant was dried in an oven to obtain the final product that is represented by the following Formula (IX):

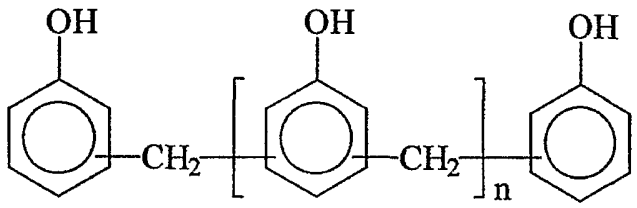


(IX)

where n has an average value of 3.4.

(B_3) To compare with the phenol resin derivatives, a novolak phenol resin

with a molecular weight of about 1000 was used, being represented by the following Formula (X):



(X)

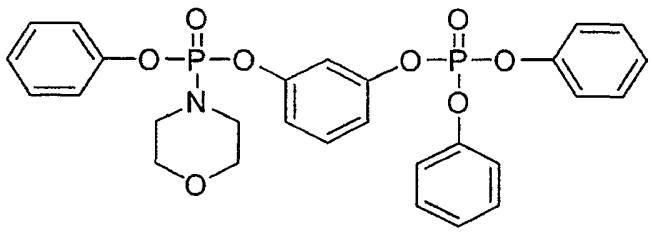
where n has an average value of 5.2.

(C) Phosphorous Compound

(C_1) Triphenylphosphate (TPP) with a melting point of 48 °C was used.

(C_2) Resorcinol diphosphate (RDP) that is a viscous liquid at room temperature was used.

(C_3) Triphenyl morpholido resorcinol diphosphate (TPP) represented by the following Formula (XI) was used:



(XI)

Examples 1-12

In Examples 1-5 and Comparative Examples 1-3, the compositions of the components are shown in Table 1. The resin compositions were extruded at

200~280 °C with a conventional twin screw extruder in pellets.

The resin pellets were dried at 80 °C for 3 hours, and molded into test specimens for measuring limited oxygen index (LOI) using a 6 oz injection molding machine at 220~280℃. The limited oxygen index was measured in accordance with ASTM D2863.

Comparative Examples 1-6

In Comparative Examples 1, 3 and 5, neither a phenol resin derivative nor a phenol resin was used, and in Comparative Examples 2, 4 and 6, a phenol resin (B_3) was used instead of a phenol resin derivative.

Table 1

	Components										LOI
	A				B			C			
	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	
Examples											
1	100	-	-	-	10	-	-	15	-	-	36
2	100	-	-	-	10	-	-	-	15	-	36
3	100	-	-	-	10	-	-	-	-	15	35
4	100	-	-	-	-	10	-	15	-	-	36
5	100	-	-	-	-	10	-	-	15	-	34
6	100	-	-	-	-	10	-	-	-	15	36
7	-	70	30	-	10	-	-	15	-	-	35
8	-	70	30	-	-	10	-	15	-	-	34
9	-	70	30	-	10	-	-	-	15	-	34
10	-	42	18	40	10	-	-	15	-	-	39
11	-	42	18	40	-	10	-	15	-	-	36
12	-	42	18	40	-	10	-	-	-	15	37
Comp. Ex											
1	100	-	-	-	-	-	-	15	-	-	21
2	100	-	-	-	-	-	10	15	-	-	27
3	-	70	30	-	-	-	-	15	-	-	23
4	-	70	30	-	-	-	10	15	-	-	29
5	-	42	18	40	-	-	-	15	-	-	26
6	-	42	18	40	-	-	10	15	-	-	30

Table 1 shows LOI of the resin compositions of Examples 1-12 and Comparative Examples 1-6. The higher LOI is, the more oxygen is required to burn

the resin, which means that a higher LOI indicates good flame retardancy.

In Examples 1-12, a phenol resin derivative (B_1) or (B_2) was used. In Comparative Examples 1, 3 and 5, neither a phenol resin derivative nor a phenol resin was used, and in Comparative Examples 2, 4 and 6, a phenol resin (B_3) was used instead of a phenol resin derivative. The LOIs of Examples 1-12 are higher than those of Comparative Examples 1-6, showing better flame retardancy.

Accordingly, use of a phenol resin derivative with good char formability in a thermoplastic resin composition can provide good flame retardancy regardless of the base resin. Even if the base resin has no or poor char formability, the phenol resin derivative can provide good flame retardancy.

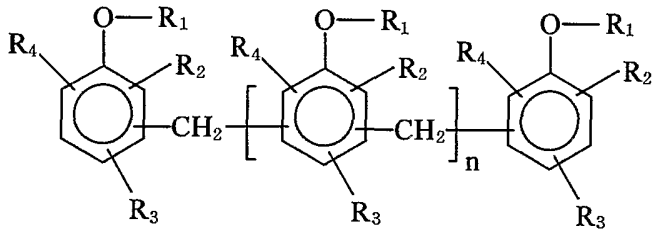
The present invention can be easily carried out by an ordinary skilled person in the art. Many modifications and changes may be deemed to be with the scope of the present invention as defined in the following claims.

What is claimed is:

1. A flame retardant thermoplastic resin composition comprising:

(A) 100 parts by weight of a thermoplastic resin as a base resin;

(B) about 0.1~100 parts by weight of a phenol resin derivative represented by the following Formula;



(I)

where R_1 is alkyl of C_{1-34}; aryl; alkyl-substituted aryl; O-, N-, P- or S-containing alkyl; O-, N-, P- or S-containing aryl; or O-, N-, P- or S-containing alkyl-substituted aryl; R_2, R_3, and R_4 are hydrogen, alkyl of C_{1-34}; aryl; alkyl-substituted aryl; O-, N-, P- or S-containing alkyl; O-, N-, P- or S-containing aryl; or O-, N-, P- or S-containing alkyl-substituted aryl; and n is an integer of 1 to 10,000; and

(C) about 1~50 parts by weight of a phosphorous compound.

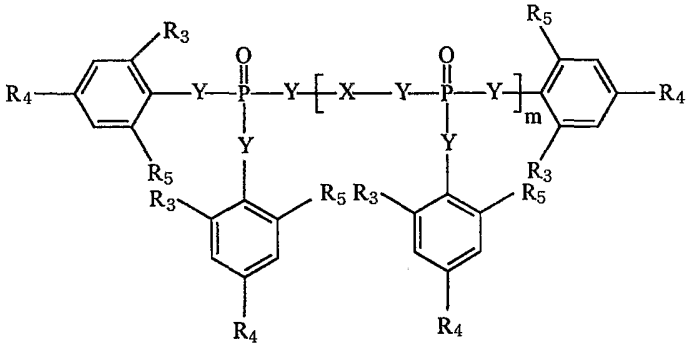
2. The flame retardant thermoplastic resin composition as defined in claim 1, wherein said base resin is selected from the group consisting of polyacrylonitrile-butadiene-styrene copolymer (ABS resin), rubber modified polystyrene resin (HIPS), acrylonitrile-styrene-acrylate copolymer (ASA resin), methacrylate-butadiene-styrene copolymer (MBS resin), acrylonitrile-ethacrylate-styrene copolymer (AES resin), polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyvinyl chloride (PVC), polymethyl

methacrylate (PMMA), polyamide (PA), and a copolymer thereof and an alloy thereof.

3. The flame retardant thermoplastic resin composition as defined in claim 1, wherein said phenol resin derivative is selected from the group consisting of o-cresol novolak epoxy resin, phenol epoxy resin and a mixture thereof.

4. The flame retardant thermoplastic resin composition as defined in claim 1, wherein said phosphorous compound is selected from the group consisting of a phosphoric acid ester compound, a phosphoamidate compound, an oxaphosphorane compound, a carboxy phosphinic acid compound, phosphoric acid ester morpholide compound, a phosphazene compound and a mixture thereof.

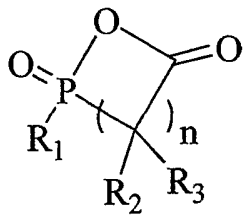
5. The flame retardant thermoplastic resin composition as defined in claim 4, wherein said phosphoric acid ester compound and phosphoamidate compound are represented by the following Formula:



(II)

where R_3, R_4 and R_5 are hydrogen or alkyl of C_{1-4}, X is aryl of C_{6-20} or aryl of alkyl-substituted C_{6-20} that are derivatives from dialcohol such as resorcinol, hydroquinol, bisphenol-A and bisphenol-S, Y is oxygen or nitrogen, and m is in the range of 0 to 4.

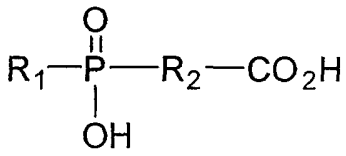
6. The flame retardant thermoplastic resin composition as defined in claim 4, wherein said oxaphosphorane compound is represented by the following Formula:



(III)

where R_1 is hydrogen, alkyl of C_{1-6}, or aryl of C_{6-15}, R_2 and R_3 are hydrogen or alkyl of C_{1-6}, and n is in the range of 1 to 3.

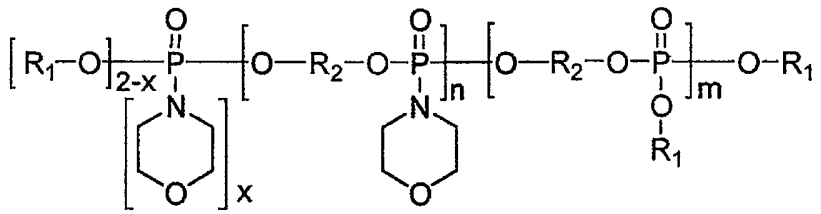
7. The flame retardant thermoplastic resin composition as defined in claim 4, wherein said carboxy phosphinic acid compound is represented by the following Formula:



(IV)

where R_1 is hydrogen, alkyl of C_{1-12}, aryl of C_{6-10}, or alkyl-substituted aryl of C_{7-15}, R_2 is alkylene of C_{1-12}, ring type alkylene of C_{1-12}, aryl of C_{6-12}, or alkyl-substituted aryl of C_{6-12}.

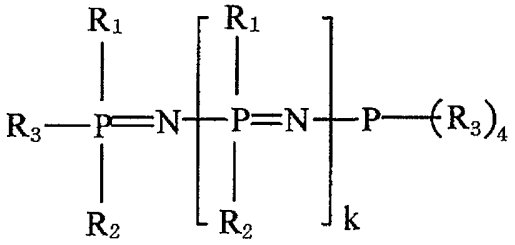
8. The flame retardant thermoplastic resin composition as defined in claim 4, wherein said phosphoric acid ester morpholide compound is represented by the following Formula:



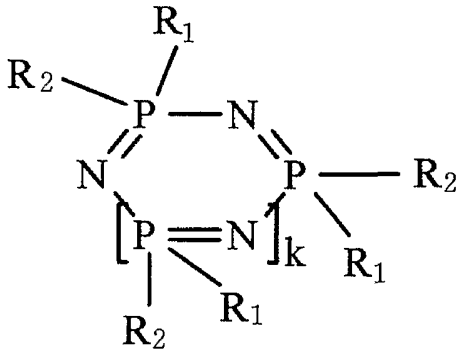
(V)

where R_1 is a C_{6-20} aryl group or an alkyl-substituted C_{6-20} aryl group, R_2 is a C_{6-30} aryl group or an alkyl-substituted C_{6-30} aryl group, x is 1 or 2, and n and m are number average degree of polymerization and n+m is 0 to 5.

9. The flame retardant thermoplastic resin composition as defined in claim 4, wherein said phosphazene compound is represented by the following Formulae (VI) or (VII):



(VI)



(VII)

where R_1, R_2, and R_3 are independently alkyl, aryl, alkyl substituted aryl, aralkyl, alkoxy, aryloxy, amino or hydroxyl, and k is an integer from 0 to 10. The alkoxy and aryloxy groups may be substituted with alkyl, aryl, amino, hydroxyl,

nitrile, nitro, or aryl with hydroxy.

10. The flame retardant thermoplastic resin composition as defined in claim 1, further comprising an additive selected from the group consisting of an impact modifier, a heat stabilizer, an oxidation inhibitor, a light stabilizer, and an inorganic filler such as talc, silica, mica, glass fiber, an organic or inorganic pigment and/or dye up to about 50 parts by weight as per 100 parts by weight of the base resin.

11. A molded article prepared by the flame retardant thermoplastic resin composition of any one of claims 1-10.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/02262

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C08L 55/02, C08L 69/00, C08K 5/49, C08L 101/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 C08L 55/02, C08L 69/00, C08K 5/49, C08L 101/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and Applications for Inventions since 1975
Korean Utility Models and Applications for Utility Models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)

NPS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 07-76649 A (DENKI KAGAKU KOGYO KK) 20 March 1995 see the whole document	1-11
Y	JP 08-208884 A ((DENKI KAGAKU KOGYO KK) 13 August 1996 see the whole document	1-11
A	KR 94-14647 A (Tongyang Nylon Co.) 19 July 1994 see the whole document	1-11

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevence

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevence; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevence; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 APRIL 2002 (24.04.2002)	25 APRIL 2002 (25.04.2002)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 920 Dunsan-dong, Seo-gu, Daejeon Metropolitan City 302-701, Republic of Korea	BAHN, Yong Byung
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5547

Form PCT/ISA/210 (second sheet) (July 1998)